Course Preparation

1. The R704B course folder containing masters for the program is located in the BWR simulator file cabinet next to the sink/coffee pot. Transparencies for the intro are in the file.

2. Make copies of the following materials for use during the course.
   Drawing Handout
   EPG/SAG Handout
   EPG/SAG questions Handout
   Duane Arnold's Transition Checklist
   Duane Arnold's SAG 1&2
   BWROGs Overview Document

3. The EPG/SAG text books for use in the course are located in the cabinet in the simulator. These are reused and should not be marked. CDs will be given out for reference to take with them. The EPG/SAGs are also accessible on the NRC website at http://papaya.nrc.gov/bwrepg/index_bwr.htm.

4. Locate the EOP transparency book . It should be in the classroom on the bookshelf.

5. Locate the transparency book containing the system figures for this course. The book is normally in the simulator by the overhead projector.

6. Student information sheets, course critique sheets, student handout sheets are located in the course folder.

DAY 1

Classroom

1.Conduct Course Introduction
   a. General
      1)Complete Student Information Sheet
      2)Introduce instructors & students
      3)Review the Student Handout Sheet
         a)Telephone system
         b)Messages
         c)Area Information
         d)Class hours - final day (12:30am)
         e)Lunch period
      4) Review the security and fire alarm procedure(where to assemble).

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b. Facilities
   1)Class room, close door when no one is in the room.
   2)Coffee mess
   3)Restrooms
   4)Food & drink
      a) vending machines on 2nd and 6th floors
      b) no snacks or beverages near or on the consoles
   5)Smoking - outside only

c. Course Overview
   1)Course Objectives
   2)Typical Course Outline

2. Review BWR set points using figures 2.0-1 and the Set points and Plant Information sheet.

Simulator

1.Initialize in IC20, 100% power, EOL, Seq. B step 927 and conduct a general tour of the control room.
   a. General maintenance - light bulbs, recorder paper, etc will be replaced by the instructors or simulator engineers only.
   b. Emergency Trip Buttons
   c. Panel locations and nomenclature
   d. Annunciator System
   e. Explanation of indicating lights convention
      1) red- breaker closed or valve open
      2) green- breaker open or valve closed
      3) blue- When off indicates a motor overload or under voltage condition, but can be operated in the emergency positions.
      4) dim white - breaker tripped and can be reset at the control panel(remotely).
      5) bright white- breaker tripped and has to be reset at the breaker cabinet (locally).
   f. Throttle valves - Handles or trim are green
   g. Equipment that can be operated at the remote shutdown panel - yellow
   h. Visual aids
      1) green dots - Rx vessel level
      2) orange dots - Pushbuttons
      3) yellow dots- Bad instrument

2. Panel review:
   a. Conduct a general discussion of the basic steam cycle using the mimic on MCB-01L.
   b. Conduct a general discussion of reactor control by the CRD system and by the RFC on the 602/603 panels.
   c. Conduct a general discussion of the EHC system.
   d. Conduct a general discussion of the FWLC system.
   e. Overview the main steam system including SRV's , RWCU, RCIC on the 602 panel.
   f. Overview LPCS, RHR, HPCI and Containment mimic on the 601 panel.
   g. Overview the main condenser, SJAE, CAR's and electrical distribution/Diesel Generators on MCB-01.
   h. Point out the Ventilation and RBSVS panels(VC1&2).
   i. Overview panel PNL-MXP
      Water systems, inst. air system to DW, DW vacuum breakers
   j. Overview the back panels pointing out the following Systems/equipment:
      Jet pump instrumentation
      Steam leak detection
      RPS
      ARM's and Process Rad monitors
      TIP's and NMS
      Remote SD panel
      Off gas panel

3. Overview the procedures and their usage. The number following the 23 or 24 is the same for the respective system.
   Index system
   22.000 series - General Operating Procedures
   23.000 series - System Operating Procedures
   24.000 series - Operator Surveillance Procedures
   25.001.01 - EOP Supplement Procedures
   29.023.00 series is EOP's in written format.

   Review ARP's and numbering system. Note the 4 digit no. on the window is the actual ARP no.. The other no.(A-1 etc.) is for locating the procedure in the ARP response book. Some ann. have reflash and may or may not be labeled as such.

4. Perform the following evolutions in preparation for EOP exercises.

   1) Power reduction, removal and restoration of 1 RFP and increase of power back to app. 100%.
   2) HPCI full flow test
   3) RCIC full flow test
   4) Suppression pool cooling

   Assign students as necessary to where all students perform all exercises in three rotations.
   Supp. pool cooling - STA and helper 2
   RCIC then HPCI - 601/602 and Helper 1
   Power red. and RFP - SRO, 603 and MCB01

5. Review the scram procedure covering the following:
   How to verify all rods FI and power decrease.
   Mode switch to Shutdown and why.
   CRD system status in scram mode
   Scram reset
   Insertion of NI's
   Reset of set point set down
   Level and pressure control
   Place the cond/feed system in SU level control and discuss why.

   Reset and repeat scrams as desired by instructor or students.

6. Scram the plant using ARI div 1 or 2 and reset the scram.
   Scram the plant using ARI both div 1 and 2 and reset the scram.
   Note the shorter time to depressurize the air header(more ARI valves are open).

7. EOP Introduction
   Overview the EPGs/SAGs using **Appendix 1.**
   At the end of the day distribute the H/Os on AMG and EPG overviews.

DAY 2

Note: This instructor guide contains a recommended outline to follow while teaching the R704B EOP course. It is intended to be used as a guide only and the scenarios contained in it are recommendations not requirements. The instructor may vary the outline and scenarios as necessary to accomplish the objectives of the course.

General Instructions:

1. All Scenerios will begin with IC20 unless otherwise specified.
2. Freeze the simulator at various points to allow discussion of actions / occurrences up to this point and field questions. Tell the students you will freeze the simulator at their request.
3. All transients should be discussed after being performed on the simulator. This discussion should cover the steps of the procedure you were focusing (objectives) and any previous objectives. Also identify problem areas or weak spots in the execution of the procedures.
4. Work closely with the students on the boards and on the procedures.
5. Rotate assignments following each scenerio unless otherwise desired.

Suggested student assignments. Rotate upward(SRO becomes the helper, STA becomes the SRO etc.):

SRO
STA
603
601/602
MCB01
Helper 1
Helper 2

Complete the remainder of the program in accordance with the following outline and attached exercises in **Appendix 2**. The exercises are sequenced such as to build your way through the RPV and PCT guidelines. In most cases malfunctions in the exercises are those which support the objective of the exercise or that portion of the EOPs being trained. If desired insert other malfunctions; however, one must evaluate if these malfunctions would alter the desired response of the plant and thus not satisfy the objective of the exercise.

Note: Appendix 4 contains a partial list of malfunctions.

Exercise# 1, RC/L - Loss of both RFPs and HPCI with final recovery on a RFP

Exercise# 2, RC/L & RC/P - Loss of both RFPs, HPCI and RCIC with 3 rods stuck out. Depressurize with BPVs to the boosters.

Exercise# 3, RC/L & RC/P - Loss of both RFPs, HPCI, RCIC and BPVs with a Main Turbine Trip. Depressurize with SRVs to the boosters.

Exercise# 4, RC/L - Loss of both RFPs with HPCI, RCIC and RFPs available.

Day 3

Exercise# 5, RC/L & RC/P - Spurious closure of all MSIVs.

Exercise# 6, RC/L, RC/P &C1 - Failure of all high pressure makeup except SLC Depressurize/rapid depressurize with BPVs to CSS.

Exercise# 7, RC/L, RC/P, C1,& C4 - RPV Flooding

Exercise# 8, RC/L, RC/P, C5 & C2 - Loss of all high pressure makeup except SLC with 3 stuck rods.

Classroom - Review Primary Containment Control Guideline using **Appendix 3**.

Exercise# 9, SP/T, SP/L, C5 & RC/Q - SRV fails open with a Failure of RPS and a hydraulic lock on the CRDs.

Day 4

Exercise# 10, SP/T, SP/L, C5 & RC/Q - RPS, ARI, SLC & 3 BPVs failed requiring deliberately lowering of level and alternate boron injection.

Exercise# 11, PC/P, DW/T, SP/T, SP/L, RC/L & RC/P - Small LOCA requiring spraying of the wetwell and drywell to preclude chugging.

Exercise# 12, RC/Q, C5, PC/P, DW/T, SP/T, SP/L - Failure of RPS with a hydraulic lock on CRD with a small break LOCA with high pressure makeup.

Exercise#13, RC/Q, C5, PC/P, DW/T, SP/T, SP/L - Failure of RPS with a hydraulic lock on CRD with a small break LOCA without high pressure makeup.

Time permitting perform the following demonstrations:

Demonstration# 1 - 100% ATWS with failure of Main Turbine without BPVs.

Fail RPS, ARI and all the BPVs (Malf. - RP03, RP06A, TC06E).
Have the students predict plant response assuming no operator action, then trip the main turbine (TC12). Have all students observe response on SPDS.

Expected response: Reactor recirc pumps will trip due to EOC-RPT followed by ATWS-RPT. SRVs will open resulting in level increasing to above L8 and tripping the RFPs. Reactor level will decrease resulting in reactor power decreasing to where steam production/steam flow is equal to makeup from the HPCI, RCIC and CRD systems. This will be approximately 23% rated power. Suppression pool/containment parameters will continue to increase based on this power input.

Demonstration# 2 - Large break LOCA. No loss of offsite power or worst single failure(Malf.RR20A at 100%)

DAY 5

Classroom

Review EPGs using the Q/A H/O then cover the entries into the SAGs.
Handout the Duane Arnold transition checklist and using the TP s overview the checklist.

Review Chapter 15 (RPV and Primary Containment Flooding SAG) Covering RC/F pages 15-14,15,16,17 and 20.

In answering the question "Has the core debris breached the vessel?", you will need to review the Ch/section 6.34 in the BWROG Overview Document or just use Duane Arnolds Flowchart.

In answering the question as to whether the injection rate is greater than the Minimum Debris Retention Injection Rate(MDRIR) use Ch 17 page 43 to define MDRIR and the curve on page 45 to see the flow rates. Note the curves on pg 45 should be labeled psig not gpm.

Handout Duane Arnolds SAG 1&2.

Notice how similar these are to the guidelines.
Look at RC/Q and RC/P.

Complete course evaluations and box books.

Appendix 1- Introduction to the EPGs/SAGs and Shoreham EOPs

1. Use the simulator overhead projector and figures B-2-1, B-2-2 and the EOP Rev 4 - Big Picture.

2. Figure - EOP Rev 4 - Big Picture
   Identify the 4 guidelines and 6 contingencies
   Contingencies provide more detailed instruction under more degraded conditions.
   Point out the entries to C6 are from C1,C4 & C5. When conditions in these contingencies cannot be met, Adequate core cooling cannot be assured (Heat removal from the reactor sufficient to prevent rupturing the cladding), thus primary containment flooding is required.

3. Figure, B-2- 1, EPG Structure and Interrelationships
   Identify the same 4 guidelines and this time only 5 contingencies.
   Each guideline protects one of the principal barriers to fission product release.

4. Figure, B-2-2 , EPG/SAG Relationships
   C6 has been replaced by the SAGs
   The entry to SAGs is the same as in Rev 4 (C1,C4 & C5) as indicated by the heavy dark lines.
   Entry to the SAGs is an exit from the EPGs(EOPs)
   SAGs consist of 2 guidelines. Entry to SAGs is entry to both.
   SAGs are a standalone procedure. The dashed lines indicate those operations that are transferred over to make them a complete standalone procedure.
   In summary the SAGs are entered whenever Primary Containment Flooding is required which is when those conditions in C1,C4 & C5 cannot be met(adequate core cooling cannot be assured).

5. Distribute the Q/A handouts

Appendix 1- Continued

6. Cover the following items using the Shoreham EOPs boards;

We only train on 2 of the 4 EOPs and do not do any training on combustible gas control in the PCT guideline.

Review the layout - overrides, exits to contingencies & SAGs, colors used etc.

Entry conditions into RPV control including "as directed into by other Guidelines".

Reentry conditions - When another entry condition is met even if you are in the procedure.

Exit conditions - As directed out within the guidelines or once it is determined an emergency does not exist even if an entry condition still exists.

Concurrent use of RC/L, P & Q is necessary due to the thermodynamic and neutronic relationship between the parameters and because the procedures are symptomatic in design. Thus the leg selected is determined by the user based on parameter trends and status of plant systems.

Purposes of the RPV Control guideline:
Maintain adequate core cooling
Shutdown the reactor and
Cool down the reactor to cold shutdown conditions

Define Shutdown per the EPGs
= Sub critical with reactor power below the heating range.
Note: Heating power is approximately 1% of rated power.
Discuss the difference between shutdown and shutdown under all conditions and how each is determined.

Define adequate core cooling
Heat removal from the reactor sufficient to prevent rupturing the fuel cladding.

What are the viable mechanisms for adequate core cooling ?
Core submergence, steam cooling(with and without injection) and spray cooling.

How does the operator determine if adequate core cooling is being achieved ?
Adequate core cooling is not achieved when:
1) In C1, water level cannot be restored and maintained above the MSCRWL or spray cooling conditions cannot be established.
2) In C4, core damage is not occuring.
3) In C5, water level cannot be restored and maintained above the MSCRWL.

Appendix 1 - Continued

Given there are a total of 8 procedures in the RPV control guideline what is the maximum number of procedures you can be in at one time? (Three, one per parameter)

Point out there are 4 possible procedures to chose from for level and 4 possible for pressure and 2 possible for power (if you count the scram procdure). Knowing the status of the reactor is key to determining which procedure you are to use and to determine if reactor depressurization is required and at what rate.

What is the minimum number of procedures you can be in?
Two (Counting the scram procedure), C-4; if reactor water level cannot be determined and the scram procedure.

What two major steps are in RC/P ?
Stabilize pressure and cooldown. There are two sub steps in stabilizing pressure
1) Stop SRV cycling (will be discussed more later).
2) Stabilize pressure with the BPVs.

Compare when RC/Q can be exited to when the reactor can be cooled down.
The conditions are the same except a cooldown can also be conducted when cold shutdown boron weight has been injected. Point out that if boron has been injected the criteria " The reactor is shutdown and no boron has been injected " **cannot** be used.

END

Appendix 2 - EOP Exercises

Exercise #1, RC/L - Loss of Both RFPs and HPCI with final recovery on a RFP

Discussion: One reactor feed pump will be tripped and following operator response the second feed pump will be tripped. Reactor level will rapidly decrease, the reactor will scram and level 2 will be reached; however, HPCI will fail to auto start. If/when the operators manually start HPCI, trip it.

Malfunction #s

- T0 - HP01
- T1 - FW01A
- T2 - FW01B
- T3 - HP02 if needed

After the transient slows, have all the operators observe the level response on SPDS. While it is recovering discuss the trend.

Makeup(feedflow) versus steam flow (steam production).

Makeup is from CRD and RCIC which is 400 GPM = to 200,000 lbm/hr or approximately 2% of rated feed flow. CRD at best is say 200 GPM another 1% of rated. Total makeup is 3%. Steam production is from decay heat and residual stored heat. Decay heat is approximately 3% two minutes following the scram and 2% in fifteen minutes. Therefore level will decrease until makeup equals steam production. It will take a long time for level to recover to above L2 unless HPCI or feedwater assists.

At this point the operators have a decision to make - to stay in the EOPs or exit.The EPG guidelines recognize that you can be in the guidelines when an emergency does not exist.When in the EOPs actions are directed/allowed that otherwise would not be since it normally is assumed an emergency exists. If they remain in the EOPs then RC/P requires a reactor cooldown be established. Without the restoration of HPCI or a RFP, feedflow could be increased by use of the boosters when pressure was reduced to their capability. At Shoreham this is somewhere <600#. At other facilities it may be <400#. Things to consider are 1)the integrated effects of time to reach the desired pressure versus cooldown effects on reactor level, 2) Cooling down the reactor using the EOPs does not require a TS data package, 3) It is not desired to cooldown without forced flow through the reactor (this is when cooldown rates of >100°F/hr have been exceeded).

To exit the EOPs the determination that an emergency does not exist must be made. This is a subjective thing; however, with no LOCA indications and the understanding of the purpose of RCIC and the desire not to cooldown without forced flow and no need to return level above L2 quickly due to other systems/equipment effected due to being <L2 one could exit. To not have to make this decision remove the trip on a RFP and restore level.

Exercise # 1 (continued)

This one time, have the students to reset and restore all systems to normal including RWCU and reactor recirc. Do not restore reactor ventilation systems.

Students should learn when:
1) to exit RC/Q
2) depressurization is required/not required
3) which procedure is being used to control reactor level and why the other procedures are not.

END

Exercise # 2, RC/L & RC/P - Loss of both RFPs, HPCI and RCIC with 1 rod stuck out. Depressurize with BPVs to the boosters.

Discussion: This exercise with the additional loss of RCIC forces the operators to stay in the EOPs and thus depressurization is required. Since the boosters are approximately 600# the pressure can be reduced and injection established without exceeding the cool down rate. Discuss this using the steam tables. Discuss the rate at which you would depressurize and the preferred method. In this case since rapid depressurization is not required it is best to decrease the pressure set to the desired pressure and leave it. One rod stuck out is to get them to looking and thinking about the status of the reactor.

Freeze the simulator shortly after the trip and handout the "Exercise" sheet. Have the students work independently to determine which procedure they are using to control level, pressure and power.

T0 - HP05
- RC02
- RD102223, one control rod stuck out in the center of the core.

T1 - FW01C
T3 - RC05 if/when RCIC is manually started

The differences between this and the previous exercise is the students may go deeper into RC/L and in RC/P they will depressurize. Students should gain an appreciation for the effects of pressure on level and feed flow and how feeding the reactor effects pressure.

Problem areas:
Not being lined up for startup level control when depressurizing.
Not controlling the feed rate - thus breaking the cool down rate.

END

Exercise # 3, RC/L & RC/P - Loss of both RFPs, HPCI, RCIC and BPVs with a Main Turbine Trip. Depressurize with the SRVs to the boosters.

Discussion: The differences between this exercise and #2 is now you will have an entry based on reactor pressure followed by level (re entry). Turbine trip will cause a reactor scram and EOC-RPT. High reactor pressure will cause SRV operations and ATWS-RPT. SRV operation will result in reaching L8 and tripping the RFPs. Stabilization of pressure will now require the use of the augmenting pressure control block in RC/P-2 (mainly by the SRVs). Depressurization will require the use of the SRVs versus the BPVs. This will be the first time SRV cycling will be observed since Shoreham does not have LLS. Have the students look up the definition of SRV cycling in the EPG/SAG book (Pg. B-6-30). Also read why cycling is a problem and why the step has a lower pressure limit.

Freeze the simulator shortly after the trip and handout the "Exercise" sheet. Have the students work independently to determine which procedure they are in to control level, pressure and power.

Malfunctions #s
T0 - TC06E
- RC05
T1 - HP04
T2 - Remote 1, TC12
T3 - Remote 2, FW01C(prevents restoration)

Students should also observe how level and pressure are effected by use of the SRVs versus using the BPVs. Suppression pool cooling should also be established.

END

Exercise # 4, RC/L - Loss of both RFPs with HPCI, RCIC and RFPs available.

Discussion: Now that the students are more familiar with the systems and procedures this exercise will be executed in real time without freezing unless asked or is necessary. This exercise is to allow them to integrate the previous training in a situation where systems are not failed. With HPCI and RCIC operating, level will restore more quickly and the challenge will be to prevent L8 from being exceeded and restoring of a RFP. The students should control the level increase by timely removing HPCI and RCIC and resetting the scram(RPS,ARI). If L8 is exceeded students should verify HPCI and RCIC are automatically removed from service, if not previously removed. In this scenerio the L8 trip on HPCI has been failed. The industry has seen failure of HPCI to trip at L8. Operators have also removed systems from service too early resulting in a low level scram after having reset the scram.

Students should restore a reactor feed pump for long term level control. Discus how to reduce level back to normal.

The loss of RFPs will be initiated by the tripping of 1 condensate booster pump. The loss of the booster will, in time, result in the trip of 1 RFP. Shortly after the first RFP trips, trip the 2^{nd} RFP. This should allow the first pump to be reset and restarted at the operator/students discretion.

Malfunction #s

T0 - HP06
T1 - remote 1, FW10A
T2 - remote 2, FW01B

Students should observe the depressurization effects of HPCI and RCIC injection.

END

Exercise # 5, RC/L & RC/P - Spurious closure of all MSIVs

Discussion: The intent of this exercise is to:

1. Emphasize the goal of always using the normal systems for level and pressure control when available.
2. Emphasize RC/P step 2 (directs control to be on the BPVs).
3. Observe how to equalize around the MSIVs.

Malfunction #s

T0 - HP06 if HPCI was secured prior to L8 in Exercise #5.
T1 - remote 1, MS10
T2 - remove MS10 after about 30 seconds. Verify the MSIVs remain closed.

Freeze the simulator shortly after the trip and handout the "Exercise" sheet. Have the students work independently to determine which procedure they are in to control level, pressure and power.

Discuss:

1) Preservation of condenser vacuum with the MSIVs closed.
2) Equalizing around and opening the MSIVs. Note, the RFPs do not trip. Will have to trip them to reduce steam loads.

END

Exercise # 6, RC/L, RC/P & C1 with 3 stuck rods - Failure of all high pressure makeup except SLC. Depressurize/rapid depressurize with the BPVs to the CSS.

Discussion: This exercise should result in the students determining that level will not be able to be maintained above L3 and thus explore that portion of RC/L where it has to be determined if it can be restored and maintained above TAF. Students should note the defeat of ADS if L1 is reached; however, the determination that TAF will be reached and not restored should be made before L1 is reached and the MSIVs close. This is necessary in order to exit to C1 so as to determine in C1 that an Emergency Depressurization (ED) will be directed. Then they can say that an ED is "anticipated" and exercise the 2nd Override in RC/P (..............rapidly depressurize the RPV with the MT BPVs ....). The exercise has 3 control rods stuck out but separated by several fully inserted rods. The students should deduce that the reactor is shutdown under all conditions without boron and thus go to C1 versus C5.

Malfunction #s

T0 - RC06 @ 1%
- RD100611
- RD103027
- RD101819

T1 - HP02

T2 - RD06A

T3 - FW10C
- HP05 (this is to ensure HPCI would not be used)

T4 - RD06B

RC06 @ 1% results in a discharge pressure of approx. 300# with reactor pressure at 900#.
Students should manually isolate HPCI and inhibit its operation.
Both boosters are lost and cannot be restored.
Upon entering C1, freeze and review it.

Challenges:

1. Determining reactor status - shutdown under all conditions without boron.
2. Determining emergency depressurization (C2) is anticipated early enough in C1 that pressure can be reduced to where CSS is injecting before L1 is reached and MSIVs close and lose the BPVs. If this occurs, pressure will increase preventing CSS injection. Note, EPGs do not address rapid depressurization using the SRVs outside of ED (C2) and according to the contractor who developed at least R2 stated they cannot be used.

END

Exercise # 7, RC/L, RC/P, C1, C4 - RPV Flooding

Discussion: This exercise establishes adequate core cooling when reactor level cannot be determined. With a loss of condensate pumps and all high pressure makeup ,except for SLC, reactor level will decrease to where C1 is entered and it is determined that ED is anticipated. At this time the operators should shift from a cooldown of <100°F/hr. to rapidly depressurizing with the BPVs. When reactor pressure reaches approximately 400# insert the failure of all level indication. This will also close the MSIVs.. However; if L1 is reached first, then the MSIVs will close from L1, terminating the rapid depressurization. If this occurs insert the failure of the level instruments at this time. Reactor level will not be able to be determined (directly or indirectly) thus exit from C1 and RC/P and entry to C4 is required. The reactor will be shutdown under all conditions without boron.

With 7 SRVs open and all CS and LPCI pumps (through the HX) operating the final reactor pressure should be around 53 psig with wetwell pressure at approximately .1 psig,.

Discuss how to determine when the RPV has been flooded to the MS Lines. Reference pg B-13-36

Malfunctions:

T0 - RD06B
- HP05

T1 - RC04

T2 - RD06A

T3 - FW11A

T4 - FW11B

T5 - When reactor pressure is approximately 400# or L1 is reached.
- RR25A,B,C,D(wide rg.),E(shutdown rg.),F(upset rg.),G & H(Fuel zone)
- RR29A,B & C(narrow rg.)

END

Exercise # 8, RC/L, RC/P, C5 & C2 - Loss of all high pressure makeup except SLC with 3 stuck rods.

Discussion: This should be the first time the reactor is not shutdown under all conditions without boron, thus the first time into C5. The three rods will not result in reactor power above 3% therefore reactor level will not have to be deliberately lowered. However level will decrease due to the loss of all high pressure makeup. Thus even though you are in C5 it is a level control problem more than a power control problem. Upon entry into C5 or if RC/L is used, freeze the simulator and see if all concur on which level control procedure should be used.

Overview C5:

ADS defeat is directed

Bypassing of the MSIV closure on L1 and Hi radiation as well as off gas isolation on hi rad is directed in our flowchart; however the placement of this step is optional depending on the ability of the plant to timely perform the bypass(see the text). Also most of the plants have or are removing MSIV closure on Hi MSL radiation.

The level control band is from MSCRWL to L8 unless level is deliberately lowered.

Systems allowed to be used to restore level are different than those in RC/L and C1. Have the students compare the lists. Systems which inject water inside the shroud are not listed until after ED and then only if systems outside the shroud cannot restore level. This is to preclude injecting cold unborated water into the fuel. All BWR 6s ECCS inject inside the shroud. If they can be realigned to inject outside then they will be listed (such as LPCI into the SD cooling return /feedwater lines).

Challenges:

Discovering that if ED is anticipated you cannot rapidly depressurize with the BPVs since the reactor status portion of the override is not met. Cooldown is then limited to 100°F based on the reactor being shutdown and no boron injected and now the override concerning reactor restart in RC/P is now applicable.

How long will it take to reach the next highest pressure system and what is this system and where do you predict level will be ?

Discovering that SLC is not on the list of systems for makeup and since you have exited RC/Q it is not "on the board". Would you use it or not ? If you do, can the reactor still be depressurized ?

ED is not performed until reactor level reaches the MSCRWL(unless directed by other steps) and then only when it is determined level cannot be restored and maintained above the MSCRWL.

Malfunctions:

T0 - RD102223, RD102227, RD102623
- RD06B

T1 - HP03

T2 - Close the A CRD pump discharge valve. This simulates a broken gear box.

T3 - Remote 1 - FW10C, FW01C,RC04

END

Exercise #9, SP/T, SP/L,C5 & RC/Q - SRV fails open with a failure of RPS and a hydraulic lock on the CRDs.

Discussion: Even though the containment parameters (SP/T, SP/L) may have been reached in earlier exercises this will be the first official entry into the PCT Guideline. The failed open SRV will cause an entry into the PCT guideline which will direct entry into the RPV Control Guideline. The reactor will not scram due to the complete failure of RPS thus RC/Q will not be exited for the first time. Freeze the simulator and ask the students what procedures are being use to control Rx level, pressure and power. Discuss the steps in RC/Q. Come out of freeze and exercise the steps. ARI will function; however, all rods will not insert due to the hydraulic lock. Reactor power will vary but should settle out <15% and may even be below 3% at times when feedflow is at or near zero. As such the reactor recirc pumps will be runback and tripped and ARI should be reset to allow for draining of the volume and subsequent scramming again by ARI. Pull the fuse on the SRV after the recirc pumps are tripped. Upon entering C5 the reactor power as mentioned earlier will by cycling and may be above or below 3%. Take the position that it is above 3% so reactor level will have to be lowered to 2 feet below the feedwater spargers. Freeze the simulator to discuss the deliberately lower steps. Resume operations and lower level to below the spargers. Note that RCIC does not have to be inhibited and it will initiate at L2. All the while the rods should be going in on each ARI scram to where they are all full in. If not, when level is stabilized in the new control band remove the hydraulic malfunction so on the next ARI initiation they will fully insert.

Continue to operate to where students transfer back to RC/L.

Malfunctions:

T0 - RP02, RD21
T1 - AD06A
T2 - Remote Function MS05 (SRV fuse)
T3 - Remove RD21

Challenge: Controlling feedflow/level. May be complicated if HPCI has not been inhibited prior to decreasing level.

END

Exercise #10, SP/T, SP/L, C5, & RC/Q - RPS, ARI, SLC and 3 BPVs are failed requiring deliberately lowering of level and alternate boron injection.

Discussion: This exercise will further explore areas in RC/Q and in C5 not previously required. Since both RPS and ARI fail to function, control rods could be inserted by selecting and driving; however to prevent any decrease in rod pattern the CRD pumps are both failed. With accumulator failures TS requires the reactor mode switch to placed in Shutdown. RC/Q will direct initiation of ARI but it is failed. Recirc pumps should be runback to minimum and then tripped. Note, the procedure has placed the plant in the instability region. SLC could be used but since no energy is going into the containment nor is there any large power oscillations it will probably not be initiated at this time. However if it is it will fail due to the inserted malfunctions. Rod insertion through pulling of RPS fuses or venting of the scram pilot air header are the first choices. Additionally, individually scramming of rods could be performed or venting the above piston. Individually scramming of rods is intended for single stuck rods when the scram can be reset. The performance of any of these insertion methods will be delayed so as to allow the performance of deliberately lowering of level to below the feedwater spargers. The timeliness of lowering level to below the FW spargers is more critical this time than in the previous exercise since you are in the instability region and the need to decrease subcooling so as to prevent or terminate oscillations.

Once level is stabilized below the FW spargers and the students have observed the effects of their operations then trip the main turbine. With 3 BPVs failing to open, reactor pressure will increase to above the scram setpoint, requiring the SRO to reenter the guideline. Pressure will cause SRV actuation and SRV cycling. Discuss SRV cycling if not done previously. Discuss the augmenting pressure control step. SP/T will increase and SLC will be required per RC/Q. Discuss how you know SLC is/is not functioning. Alternate boron injection should be directed. Once SP/T increases to >110°F, all the conditions necessary to deliberately lower level will be met. Continue to decrease level to where the SRVs are closed and pressure is controlled with the 1 remaining BPV. Pull the RPS fuses when the plant is stablized. Note, that PC/P will increase due to the SRV operations and loss of DW AHUs at L1 if level is needed to be lowered to <L1. If this occurs before the SRVs are closed the requirements to lower level may still apply. Also SP cooling, if established will be interrupted and in order to restore it, the LOCA initiation signal on the valves will need to be operated.

Malfunctions:

T0 - RP02, RP06B, TC07A, B & C, SL01A & B, RD06B
T1 - RD06A
T2 - RD091419
T3 - RD092631 & RD091427
T4 - TC12
T5 - RPS A fuses, RP05A,C,E,G
T6 - RPS B fuses, RP05B,D,F,H

END

Exercise #11, PC/P, DW/T, SP/T, SP/L, RC/L & RC/P - Small LOCA requiring spraying of the wetwell and drywell to preclude chugging.

Discussion: This is the first exercise with a LOCA. A small LOCA is established through high vibration on the "A" recirc pump eventually causing loss of #1 seal shortly followed by the #2 seal. In addition the vibration causes a weld failure on a riser pipe. Students will respond to the seal failure and most likely isolate the "A" loop. DW pressure will continue to rise as the riser leak is increased. Students will manually sram the reactor or it will automatically scram on high DW pressure. Both the PC and RPV guidelines will be entered on DW pressure. Hi DW pressure will cause ECCS initiations and lock out containment spray/cooling and SW cooling requiring overrides to be used to establish cooling and sprays when directed. HPCI will most likely increase level to L8 unless the students take control. This will cause a loss of the RFPs.

Continue to increase the riser break size to drive DW pressure. Reactor pressure will vary according to cold water injection but should remain around 900#. PC/P will require the wetwell to be sprayed. The goal is to increase wetwell pressure to >9# so the DW spray operation can be performed. Three rods will be stuck to distract/challenge the SRO to not depressurize. In most cases the students will be preoccupied with the PC guideline since all rods fully insert and reactor level is high and as such will not address RC/P and establish a cooldown. If cooldown is established right away then the reduction in reactor pressure will kill the increase in DW pressure and the goal of spraying the DW will not be obtained unless you create an additional leak. Malfunction RR20A at 1% may work. In addition DW cooling is lost due to the LOCA signal. DW/T directs restart of the coolers; however, we don't do it. If the reactor is not depressurized discuss how this operation and restoration of DW cooling would have helped.

Malfunctions:

T0 - RD100611,RD102623, RD105035
T1 - RR06A with severity increased to alarm
T2 - RR09A
T3 - RR10A
T4 - RR21 with severity increased to 100% at desired rate
- MS01 with severity increased to 100% at desired rate
T5 - If necessary, RR20A at 1%.

END

Exercise #12, RC/Q, C5, PC/P, DW/T, SP/T, SP/L - Failure of RPS with a hydraulic lock on CRD with a small break LOCA with high pressure makeup.

Discussion: This exercise provides a co-ordinated challenge of ATWS and LOCA. Unlike the previous exercise where the reactor was shutdown and a cooldown was directed this time a cooldown is not allowed. As such the energy transfer to the containment cannot be minimized by depressuizing. ARI will function and after repeated scrams the reactor will be shutdown with no boron injected thus satisfying the depressurization step in RC/P. If SLC is initiated and injected, the reactor can be depressurized. when cold shutdown boron weight is injected.

Malfunctions:
T0 - RP02, RD21
T1 - RR21increased to 100%
- MS01 increased to 100%

END

Exercise #13, RC/Q, C5, PC/P, DW/T, SP/T, SP/L - A hydraulic lock on CRD with a small break LOCA without high pressure makeup.

Discussion: This exercise involves 3 concurrent problems; ATWS, LOCA and loss of high pressure makeup except for CRD and SLC. With the loss of RFPs,RCIC & HPCI reactor level will decrease. The decrease in level will decrease reactor power as the recirc pumps have run back on feedwater. The decision on if the reactor is shutdown may be a point of hesitancy as it will partially depend on how soon after the scram they male the determination. It may hover around 3% then decrease as there is no cold water injection; however it will decrease to 1% and lower when the recirc pumps are tripped in RC/Q or by L2 and the continued decrease in level due to the LOCA and boil off . If the reactor is determined to be shutdown and no boron has been injected then the plant can be depressurized at < 100oF which would be desired to reduce the energy transfer to the containment and to get to the boosters for level control. The interesting thing is that if the decrease in level is such that the the reactor is determined to be shutdown and no boron injected, this also satisfies the override out of RC/Q. If RC/Q is exited then SLC is not on the board as it is not listed in C5. If RC/Q is not exited then SLC may be initiated. If boron is injected then the override out of RC/Q on "reactor shutdown and no boron injected" can not be used. More than likely what will occur is that RC/Q will not be exited and SLC will not be initiated. Rods will be inserted through repeated scrams(defeat RPS, malf. RP03) which will "shutdown" the reactor. Then what is done about depressurizing and/or exiting RC/Q will depend on if boron has been injected. If boron is injected, then depressurizing can not take place until Cold Shutdown boron weight has been injected or when the reactor is SD under **all conditions** without boron. Depressurizing brings emphasis to the override step in RC/P concerning reactor restart/criticality. The goal will be to get to the booster pumps to maintain level without going critical again.

At Shoreham the MSIV closure on L1 and Hi MSL radiation is bypassed early in C5. This bypass may not be allowed at other facilities as its placement in the procedure depends on if the bypass can be quickly and easily bypassed (see text). As such if the bypass is not exercised the MSIVs will close at L1. Procedurally, if they close they cannot be reopened per our procedure as RC/P only allows reopening if boron injection is required (see Text). This would require depressurization to be performed by use of the SRVs. LOCA load shed will occur at L1. The CRD pump can be restarted after a short time delay and power to the SRM/IRM drives will have to be overridden/restored. Spraying and cooling of the containment will require overrides as well.

Malfunctions:

T0 - RD21, RC05
T1 - HP05
T2 - RR21 increased to 20% or as desired
- MS01 increased to 20% or as desired
T3 - FW01C inserted when the reactor is scrammed or scrams

END

Appendix 3 - Primary Containment Control Guideline

1. Overview the 3 types of containments using the containment figures.
   In general:
   All use the same PSP method.
   One difference between Dresden II & III versus other containments is that Dresden has external wetwell to drywell vacuum breakers vs. internal.
   Mk III
   Has the upper pool which ensures water level is maintained at least 2' above the top row of horizontal vents on a LOCA (SPMU). The drawdown on the pool continues until the level inside the drywell spills over the weir wall. On a Mk I it only takes a small amount of water to build up on the drywell floor before it returns to the pool through the vent pipe.

   Water is used as shielding vs. solid shielding.

   There is no fuel storage in the pool. Fuel storage building and transfer canal.

   The wetwell air space is the reactor building.

   Drywell is not a fission product barrier.

   The terminology "reactor building and secondary containment and dry well/wet well and primary containment" are not equivalent.

2. Using figure B-2-1: EPG Structure and Interrelationships discuss the following:
   - Purpose of the guideline (maintain the integrity of the containment and protect equipment in the containment)
   - CN/T is used only for Mk III containments, therefore it is not in our procedures.
   - PC/G is not trained on here as the simulator does not support it.
   - As in the RPV Control Guideline the rationale for the entries and the values for entry are the same and when an entry condition is met all parameters are evaluated concurrently.

Appendix 3 (continued)

3. Using table 7.5-1 from the advanced manual, compare the following items:
   Design pressures for DW & WW(internal and external).
      Maximum allowed is 10% higher. Expected failure is over 100# for a MkI.
   Max calculated LOCA pressures for DW & WW
   Design temperatures for DW & WW Note: no value is given for the pool water temp.
   Wet well air space volumes.
   Wet well water volumes.
   Types and number of vents
   Suppression pool temperature increase on a DBLOCA
   Inerting requirements
   RHR heat exchanger heat removal capabilities. Note; if these are calculated out it is around 2.4% of rated power for Mk I and III and about 1% for a Mk II.

4. In reviewing this guideline, concerns on the PC will be covered rather than covering specific steps. Solicit the concerns from the students. Use TPs on BFNPs primary containment in covering the concerns.

Primary Containment Concerns

1. SP/T (Reference pg B-7-21 thru 23 and Cautions #3&5 in section B-5)
   Although there is a design value or limit for low temperature it is the increase in temperature that the EPGs are concerned.
   - Heat capacity (Heat capacity temperature limit, HCTL). Exceeding the ability to absorb the energy from a LOCA or ADS operation. Unstable steam condensation from the SRVs.
   - Exceeding NPSH
   - Previously in Rev 4 there was a concern with cooling for RCIC & HPCI. Cooling water for the lube oil is the water they are pumping. In Rev 4 a pool water temp of 140°F was the limit relative to lube oil cooling. Operation of HPCI and RCIC with suction from the pool was not allowed in rev 4 even if the CST was not available. As such the suction transfer from the CST to the pool on hi pool level was always defeated. The new temperature of concern for lube oil is 225°F (See Caution #5). In the EPG/SAGs if the CST is **not available,** suction **can** be from the pool. The suction transfer on hi pool level is still defeated as long as the CST is available since the CST provides less concern for NPSH, water quality and cooling.

Appendix 3 (continued)

2. SP/L (Reference pg B-7-44 thru 53)
   Low - HPCI exhaust line coverage (specifically when the holes in the pipe begin to uncover)
   - Uncovering the downcombers
   - Heat capacity
   - SRV coverage
   - NPSH
   - Vortexing

   High - Wetwell to drywell vacuum breakers
   - SRV tail pipe level limit (STPLL)
   - Wetwell spray header

3. DW/T (Reference pg B-7-26 and Cautions)
   - Effects on reactor water level instrumentaion
   - Exceeding design temperature of equipment in the dry well. (ADS)
   - Exceeding design temperature of the drywell.

Appendix 3 (continued)

4. PC/P (Reference pg B-7-33 thru 37)
   - Chugging (Mk I & II only) Cannot occur in Mk III due to horizontal vents.
     Dry well is sprayed when the suppression chamber spray initiation pressure(SCSIP) is exceeded.
   - Exceeding the Pressure Suppression Pressure Limit (PSP). Assurance the pressure suppression function of the containment is maintained while either the RPV is at pressure or primary containment flooding is required. Maintain suppression chamber pressure below the pressure suppression pressure (PSP) limit.
     PSP is the lessor of:
     - Exceeding the highest suppression chamber pressure which can occur without steam in the supp. chamber airspace.
     - Exceeding the highest suppression chamber pressure at which initiation of RPV depressurization will not result in exceeding the PCPL A before RPV pressure drops to the Minimum RPV Flooding Pressure.
     - Exceeding the highest suppression chamber pressure which can be maintained without exceeding the suppression pool boundary design load if SRVs are opened.
   - Exceeding the Primary Containment Pressure Limit A (PCPL A) Exceeding the limit may challenge primary containment vent valve operability, SRV operability, RPV vent valve operability, or the structural integrity of the primary containment.
     PCPL-A is the lessor of:
     - The pressure capability of the primary containment
     - The maximum primary containment pressure at which vent valves sized to reject all decay heat from the containment can be opened and closed.
     - The maximum primary containment pressure at which SRVs can be opened and remain opened.
     - The maximum primary containment pressure at which RPV vent valves can be opened and closed.

Show video on chugging if students have never seen it.

END

Appendix 4 - Partial List of Malfunctions

Automatic Depressurization - AD

SRV leaks	AD05A-K
SRV fails open	AD06A-K
SRV sticks open	AD07A-K
All SRV's Fail closed	AD08
SRV vac.brk.fail open	AD09

Core Spray - CS

Pump trip	CS01A or B
Inj. vlv fails	CS02A or B
Full flow test fails	CS03A or B

Diesel Generators - DG

Fail to start	DG01A,B or C
Output brk fails to close	DG02A,B or C
DG trip	DG03A,B or C

Feedwater - FW

RFP trip	FW01A or B
Both RFPs trip	FW01C
CB trip	FW10A or B
Both CB trip	FW10C
C trip	FW11A or B
Both C trip	FW11C
Ind M/A fails Hi	FW05A or B
Ind M/A fails Lo	FW06A or B
RFP loss of lube oil	FW02A or B
RFP vibration	FW07A or B
Pipe rupture in TB	FW20
SF detector fails DS	FW08A-D
SF detector fails US	FW24A-D
FF detector fails DS	FW09A,B
FF detector fails US	FW25A,B

HPCI - HP

Fails to auto start	HP01
Trips	HP02
Disch line break	HP03
Steam line break	HP04
HPCI spurious trip	HP05
Fails to trip on L8	HP06

Main Condenser - MC

Air inleakage	MC01
SJAE steam sup block	MC04
Circ water pp trip	MC05A-D

Main Steam - MS

Seam leak inside PC	MS01
SLRupture inside PC	MS02
SLRupture outside PC	MS03
SL leakage outside PC	MS04
Seal reg. fails closed	MS06
MSIV disk separation	MS07A-H
Spurious MSIV closure (all)	MS10

Neutron Monitoring - NM

LPRM Hi	NM06XXYYZ
LPRM Lo	NM07XXYYZ
IRM HiHi	NM08A-H
IRM DS	NM09A-H
IRM inop	NM10A-H
IRM retrct failure	NM11A-H
APRM US	NM12A-F
APRM DS	NM13A-F
APRM inop	NM14A-F

Primary Containment - PC

Loss of DW cooling	PC03A or B

SLC - SL

Squib fail to fire	SL01A or B
Pump trip	SL02A or B
Relief valve fail open @880#	SL03A or B

RCIC - RC

Loss of oil pressure	RC01
Failure to auto start	RC02
Fail to trip	RC03
Auto isolate	RC04
RCIC Trip	RC05
Variable speed	RC06
Fails to trip on L8	RC07

Rod Drive - RD

SM vol dr. vlv fail cl	RD02A & B
SM vol vent fail cl	RD24A & B
FCV fails closed	RD04A or B
FCV fails open	RD03A or B
Pump trip	RD06A or B
Rod drift in	Pg.RD2
Rod drift out	Pg. RD-
Rod Hyd Lock	RD21
Suction filter clogging	RD05

RHR - RH

Pump trip	RH05A-D
Outbd Inj vlv fails(36)	RH08A or B
Inb Inj vlv fails(37)	RH10A or B

RPS - RP

MG trip	RP01A or B
Fail to S/M complete	RP02
Fail to S/M auto	RP03
ARI fail complete	RP06B
ARI fail auto	RP06A
Spurious scram AorB	RP07A,B
Spurious scram A&B	RP07C

Reactor

Fuel failure	RX01

Reactor Recirc - RR

Dr. Motor brk trip	RR02A or B
Control sig fail	RR04A or B
Hi vibration	RR06A or B
Speed sig fail	RR08A or B
Seal failure, inner	RR09A or B
Seal failure, outer	RR10A or B
Master cont. fail Hi	RR15
Master cont. fail Lo	RR16
Loop leakage	RR21
Loop rupture	RR20A or B

Main Turbine - TUO

Hi vibration	TUO3A-J
loss of lube oil	TUO6

Turbine Control - TC

All BPV's fail open	TC05E
All BPV's fail closed	TC06E
Ind BPV fail closed	TC06A-D
Ind BPV sticks	TC07A-D
EHC reg fails Hi	TC01A or B
EHC reg fails Lo	TC02A or B
EHC reg oscillates	TC03
Turbine trip	TC12